

## AGENCY OF FIRE IN PROPAGATION OF LONGLeAF PINES

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(WITH FIVE FIGURES)

The important part played by forest fires in the life history of the longleaf pine has been recognized by a number of recent writers, and HARPER<sup>1</sup> even goes so far as to say "that if it were possible to prevent forest fires absolutely the longleaf pine . . . . would soon become extinct." The connection between the periodic recurrence of these catastrophes and the success of the pine seedlings in competing for possession of the soil was pointed out by Mrs. ELLEN CALL LONG, of Tallahassee, more than 25 years ago, but the suggestion appears on the face of it so at variance with universal experience as to give little occasion for surprise that it should have been received with incredulity, or at best with indifference, by those unacquainted with the adaptive provisions of the species and the conditions prevailing in its habitat.

The writer has recently been favored with exceptional opportunities for investigating this subject by means of an experiment carried out by nature herself, in the native home of the longleafs, with all the exactness of detail that could be expected in a well ordered laboratory. Even that refined test of scientific accuracy, a control experiment, was provided by a neighboring group of the same species that was not exposed to fire on the occasion referred to. The scene of this spontaneous demonstration lies on the northern slope of Lavender Mountain, in Floyd County, Georgia, a ridge of the Southern Appalachians which is certainly very near, if not actually itself, the extreme inland and upland limit of the longleaf pines as they occur at present. The crest of the ridge, according to the United States Geological Survey, attains a maximum height of 1695 ft. above sea level, and extends for 12 miles or more in an approximately east and west direction. It is divided

<sup>1</sup> Economic Botany of Alabama, Part 1, p. 26.



transversely by three deep depressions, or gaps, through which traffic is carried on, and the intervals between the gaps are subdivided by numerous ravines into more or less widely separated spurs and knobs. The southern slopes are covered with the remains of great forests of this valuable timber, interspersed with various hardwood trees and with shortleaf pines (*P. virginiana* and *P. echinata*).



FIG. 1.—Young longleaf pines reforesting mountain side after removal of ripe timber

They have repeatedly been cut for lumber and burned over by "ground fires" started in spring by farmers to provide a free range for their cattle, but the longleafs continue to reproduce themselves with a pertinacity which, if not too diligently thwarted by the blundering incompetence of county officials and the shortsighted greed of ignorant timber cutters, will in the course of a generation or two repopulate the southern mountain slopes with a new forest growth sprung from the old stock (fig. 1).



While there are traditions of the former presence of this species on the northern side of the mountain, the only traces of them that I have been able to find there consist of two small, isolated groups which furnished the apparatus for nature's instructive experiment alluded to. They are situated on opposite sides of a deep ravine which starts near the top of the mountain, at Fouché Gap (the westernmost of the three passes), and descends in a gradually widening rift to the bottom. The larger and more important of these groups occupies a portion of a steep incline between the crest of the ridge and a now abandoned road that winds along the eastern edge of the ravine. It numbered only five individuals, so far as could be seen when I first took note of them, in the summer of 1913. Of these, the rugged patriarch shown in the center of fig. 2, together with two smaller specimens in the background, one of them a mere sapling, were the only members of the colony conspicuous enough to attract the attention of any but a particularly interested observer. The other two were seedlings not over 4-5 dm. in height, and at this stage of development, when the needles are the only part above ground, so like the coarse grasses around them that even an expert, unless keenly on the lookout, would be liable to pass them by unnoticed (fig. 3).

This group of five individuals was scattered over an area of half an acre, more or less, on the edge of an open copsewood which has repeatedly been cut for timber and cleared of undergrowth by minor forest fires. The rest of the declivity, from the gap to the crest of the ridge, had been cleared several years before for cotton planting, but after a short trial was abandoned as too rugged for cultivation. It was at this time (July 1913) neck deep in weeds, mixed with a scrub growth of brush and brambles; and not being in quest of the zoological specimens likely to abound in such places, I did not explore this jungle until two years later, after one of the periodical spring fires had cleared the ground.

The second group, which served as the "control," is situated on the farther side of a low spur or knoll, separated from the neighboring colony by the intervening ravine and the wooded crown of the knoll. It included, when first observed, four individuals, three of which were adults of full cone-bearing age, the



largest one measuring 2 m. in girth. The offspring of these was limited to one solitary seedling, a disproportion the significance of which will be apparent later, when compared with the progeny of the "patriarch" on the other side of the gorge. The soil in both situations is the same, a hard, dry, rocky clay, with a characteristic



FIG. 2.—In foreground, small portion of old clearing as it appeared after fire, with "patriarch" on border between it and copsewood; tall *Pinus echinata* dimly outlined at extreme left stands near brow of opposite slope of ravine; beyond is knoll on farther side of which "control" group is situated.

ground cover of *Pteris aquilina*, *Tephrosia virginica*, and a number of coarse grasses that have a strikingly familiar aspect to one acquainted with the vegetation of the great pine region of the South Atlantic coastal plain. The typical wire grass (*Aristida stricta*) of



the southern forests is here replaced by a correspondingly arid growth of "old field broom" (principally *Andropogon furcatus*, *A. virginicus*, and *A. scoparius*), with a few sedges (*Scleria triglomerata*, *Cyperus retrofractus*, etc.) intermixed. In fact, the only difference in the environment of the two groups is the isolated position of the knoll,



FIG. 3.—Large clump of spearlike leaves near upper lefthand corner is longleaf seedling; others are grasses that have sprung up since fire; skeleton plant on right and white patches in background are hardwood seedlings and bushes killed by fire that left pine seedling unharmed.

the top of which is protected by an encircling turnpike road and by the wooded slopes of two deep ravines, watered by mountain springs and clothed with a heavy growth of broad-leaved trees, conditions which oppose an effective barrier against the spread of fire.



It was not until April 1915 that I made another visit to these straggling longleaf outposts, which had interested me at first merely as landmarks of what seemed to be the *ultima Thule* of their advance in this direction. But a great surprise awaited me. The region around the gap had recently been burned over, and amid the wreckage of skeleton limbs and blackened stubs to which the weedy jungle in the old clearing was now reduced, there appeared a thriving colony of 33 young longleafs, ranging from a few decimeters to a meter or more in height. This new growth was confined mainly to the old clearing, although the "patriarch," whose progeny it presumably is, stands squarely on the border line between the old cotton field and the copsewood, and had no doubt distributed his favors impartially to both. But the absence of trees in the clearing would naturally facilitate the scattering of seeds in that direction, and during the first year or two, before the weeds and brush began to crowd them out, they would germinate freely in the open ground. I had simply overlooked them on my former visit, for the reason that they were hidden in the jungle, where, after making a successful start in life during the palmy days before their little Belgium was overrun by the horde of weedy invaders, they were at last overpowered by numbers and buried out of sight. Deprived of the sunshine so necessary to this sun-loving race, all save the oldest and strongest among them must have perished but for the timely intervention of their powerful ally, the fire, which swept away all rivals and left the young longleafs in undisputed possession of the soil. That such was the case, we have their own direct testimony, for every one of them bore unmistakable marks of fire. Some were so scorched and blackened that any one unacquainted with the habit of the species would unhesitatingly have pronounced them dead. An examination, however, of a number of the worst injured plants showed that in not a single instance had the growing point been killed, or even seriously damaged.

On the other side of the ravine conditions were unchanged except that a new road had been cut around the knoll since my former visit, almost completely encircling it, and one of the adult pines that stood in their way had been felled by the road builders.



The fire had not spread in this direction, and I had some difficulty in finding again, among the coarse grasses which these nurslings so closely resemble, the solitary seedling upon which the future hopes of the colony depend. A careful search among the undergrowth failed to bring to light any further additions to this decadent family, and, as matters now stand, it looks as though the last remnants of the longleaf forest that once clothed the knoll were doomed to early extinction.<sup>2</sup>

It would, of course, be rash to attribute this result solely to the absence of fires. Various other factors may intervene, among which must be reckoned the infrequency of seeding that characterizes this species, a full crop being produced only at intervals of four or five years. If a forest fire should occur during one of these "lean" periods, it would have comparatively little effect, since there would be few seedlings to take advantage of the opportunity offered, while one closely preceding a season of abundance would prepare the way for a proportionate increase in the longleaf population.

Another fact to be considered is that the early growth of the longleaf seedling is very slow. The main energy of the plant during the first year or two is expended in developing the long taproot which enables it to cope successfully with the poverty of its habitat by making the most of the meager resources of the soil, and later provides a safe anchorage for the towering shaft of the adult tree. The young specimen shown in fig. 4, and scarcely distinguishable as yet from a clump of grass, is not less than two years old, and may be more. But while giving due weight to these considerations, I think that after we have studied the effects of fire a little more closely in those cases where its agency is too obvious to be doubted, we cannot deny that it is, and has been in the past, an important factor in the propagation and distribution of the longleaf pines.

In July and August of the same year (1915) I made a longer stay on the mountain, during which time I was able to continue my observations on the pines to better advantage. In the lower

<sup>2</sup> Later observations (September 1917) show a flourishing group of 66 saplings and seedlings in the first colony; while the lower one on the knoll has been reduced to 2 individuals by the loss of the seedling and one of the adult trees.



group, on the knoll, there was little of interest to record, everything remaining very much as when I last saw it. On the upper slope, however, matters were very different, and a more exact count brought the census of the new generation up to 40. Of this number, all of those within the old clearing must have germinated during the 7 or 8 years since the cultivation of this part of the land



FIG. 4.—Thrifty longleaf seedling that has established itself successfully on stratum of almost solid rock, made possible by long taproot reaching far down into subsoil.

was abandoned, for they would assuredly have been weeded out had any of them dared to show their heads above ground where "cotton was king." To estimate the ages of different individuals with accuracy, however, is not easy, on account of the great irregularity in the rate of growth. While very slow during the first 2 or 3 years, as already pointed out, it becomes proportionately rapid after the critical period of "infant mortality" is past. The growth for the year 1915, up to the first of August, on two saplings of 2.75 and 2 m. in height respectively, was found by measurement



to be approximately 8 and 7.5 dm., while seedlings 12-18 cm. high showed a gain of only 2-4 cm. for the same period.

These figures show that the young longleaf, after attaining adolescence, is fully capable of holding its own in the competitive strife of the plant world. The chief danger to the species in this unceasing contest is in the risk that the seedling, during its long period of infancy, may be starved and crowded to death by the rapidly advancing host of weeds and bushes that outstrip it in the battle for food and sunlight. Their only safeguard against these enemies is, as we have seen, the forest fire.

This naturally brings up the question, how does it happen that the young pines themselves are not killed by the heat which destroys their hardier competitors? The answer is before our eyes. The great rosettes of bristling needles, which give to the longleaf pine its venerable aspect, are not the mere decorative emblems of ancient descent that they seem. They are fulfilling the important function of a defensive armor against the most destructive enemy (after man) that the plant population of the world is exposed to. The young of most species quickly succumb at the first onset of even an ordinary ground fire; but the longleaf pine seedling has its growing point closely enveloped in a crown of spearlike needles, as shown in fig. 4, before the stem begins to rise above the ground. These may be anywhere from 20 to 40 cm. long, including the sheaths, which average about 3-4 cm. When fresh they ignite so slowly as to be practically incombustible. Strictly speaking, they can hardly be said to ignite at all, but are bitten off and consumed where the fire comes in contact with them. Moreover, the application of heat causes a violent sizzling and contortion of the parts affected, accompanied by a series of small explosions which are sometimes capable of extinguishing a match; and I have even known them, on one occasion, to put out the flame of a candle. At another time, I was trying to ignite a fresh "pinetop" (as these tufts are called in our Georgia vernacular) by the flame of a kerosene lamp, when it fumed and sputtered and caused such a commotion in the burning wick that I cut short the experiment for fear of exploding the lamp and transferred my operations to the kitchen. There was a slow wood fire in the



stove, into which I thrust the pinetop, and awaited results, watch in hand. When I removed the stub at the end of 4 minutes, the needles had all been consumed, but the sheaths, especially those of the vigorous young fascicles crowded around the growing point, remained for the most part intact. The bud itself, though considerably scorched and blackened externally, appeared, like the stem, not to have suffered beyond the possibility of recovery, though this point, as the final result will show, was open to doubt.

It may be explained here that in excursions through the mountains it is desirable to avoid all unnecessary encumbrances in the way of luggage, and, as the conditions of life are very primitive in the regions of greatest interest to the botanist, one often has to resort to homely makeshifts when supplementing observation by experiment. It is surprising, however, what interesting results may sometimes be obtained by very simple means when one is determined to get to the bottom of a thing.

To complete the experiment, I next placed a couple of fresh pinetops in an upright position over a brisk blaze of chips and twigs out of doors, so as to approximate, as closely as possible, the normal conditions of an ordinary brush fire. After 8.5 minutes, when the flame had subsided and the needles were all burned away, down to their sheathed bases, I placed the stubs in water, together with the one that had been subjected to the ordeal of the kitchen stove on the day before. At the end of 12 days, when my stay on the mountain came to an end, the latter was found to have sustained internal injuries which left it in all probability beyond recovery. The other two came out of the fiery ordeal, if not altogether unscathed, yet with an appearance of vitality sufficiently unimpaired to warrant the presumption that had they remained attached to the living stem, like their kindred in nature's outdoor experiment, they would, like them, quickly recover from the effects of the fire.

The effectiveness of this provision for the safety of posterity is further assured by the tendency of the needles to persist on the stem of the young shoot for several years, until the more delicate parts are lifted beyond the reach of danger. As the growth of the sapling progresses, and the increasing thickness of the bark provides for the protection of the stem, the needles become massed



around the growing axes at the end of the branches, where they form the tassel-like clusters or "pinetops" which are such a striking characteristic of the longleaf pines (fig. 5). Under the influence of light the lateral stems supporting these tassels tend to curve upward. This upright position has the advantage that the fire, which

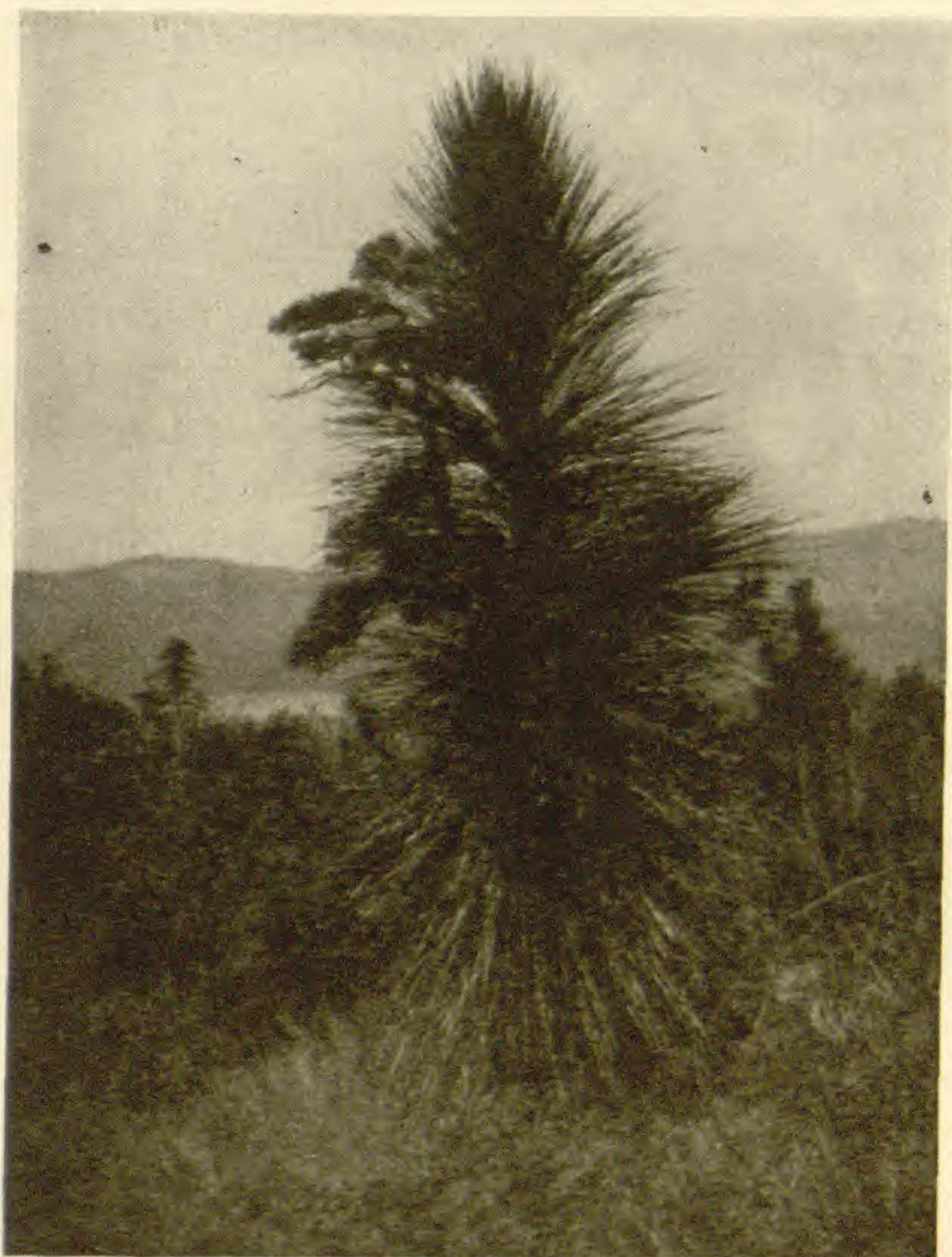


FIG. 5.—Young longleaf pine with stem surrounded by bristling *chevaux-de-frise* of needles, growth of several successive years.

ordinarily makes its attack from below, has to cut its way through the entire phalanx of protecting needles before it can reach the growing point. If the rosettes were drooping as in the winter condition of the white pine, they would, instead of protecting the buds, act as refractors to converge the heat upon them.



With such efficient fire protection it can easily be seen why the longleaf seedling is able to withstand a degree of heat that would be fatal to older and in other respects hardier plants. The same facts also explain why, in a state of nature, these trees tend either to congregate in pure forests over large areas or to become extinct if exposed to unrestricted competition with hardwoods. In the latter case the older conifers may hold their own for a time, but as these die out from superannuation or other causes, the new generation that should replace them, unable to develop in the shade, and cut off from the sunlight by the broad leaves of the hardwoods, fails to reach maturity and the race in time becomes extinct. On the other hand, when forest fires, especially of the minor type known as "ground fires" and "brush fires," occur at not too frequent intervals, the immunity of the pines enables them to take the lead in the work of reforestation, and through the gradual elimination of their rivals to become finally the sole possessors of the soil.

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